CONNECTICUT RIVER BASIN ANADROMOUS FISH RESTORATION: Coordination and Technical Assistance F-100-R-32

Annual Progress Report
October 1, 2014 - September 30, 2015

U.S. Fish and Wildlife Service
Connecticut River Coordinator's Office
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Executive Summary

Federal Aid Project # F-100-R-32

States: Connecticut, Massachusetts, New Hampshire and Vermont

Project Title: Connecticut River Basin Anadromous Fish Restoration: Coordination and Technical Assistance

Period Covered: October 1, 2014 - September 30, 2015

This annual report provides an opportunity to organize and document, to varying degrees, all work activities conducted by the Connecticut River Coordinator's Office, which includes work outside of the Connecticut River basin and numerous activities not funded by this grant.

Objectives:

- Coordinate the Connecticut River Anadromous Fish Restoration Program as a unified effort of State and Federal fishery agencies
- Provide technical assistance to the fishery agencies and other program cooperators
- Identify fishery program priorities, design and implement projects to address issues and opportunities, and develop plans
- Administer several different federal grant programs to address fish habitat, passage, management, and research projects

Accomplishments:

Program Coordination

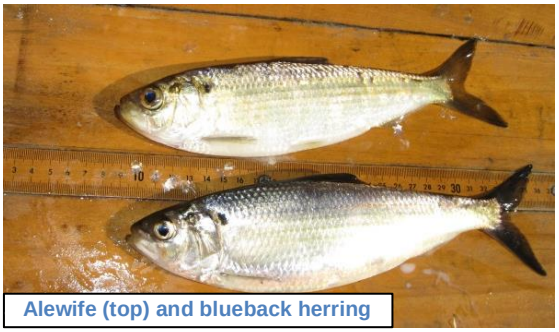
- Coordinated two Connecticut River Atlantic Salmon Commission (CRASC) and two CRASC Technical Committee meetings
- Organized the CRASC Technical Committee Research Forum (March 2015) http://www.fws.gov/r5crc/pdf/CRASC_Research_Forum_Program_Agenda_2015.pdf
- Organized CRASC Shad Studies and River Herring subcommittee meeting
- USFWS officer for U. S. Geological Survey Conte Anadromous Fish Research Laboratory (CAFRC) – American shad research on temperature effects (2015-2017), USFWS Science Support Program
- Provided annual upstream and downstream fishway operations letter to hydropower owners and Federal Energy Regulatory Commission (FERC).
- Assisted in coordination for National Oceanic Atmospheric Administration Woods Hole Lab (NOAA) – American shad reproductive patterns and rates on migration (2015)

- Coordinated river herring population assessment and restoration activities in the Connecticut River basin
- Coordinated and served as lead writer for CRASC - River Herring Restoration Status and Plans in the Connecticut River Basin (February 2015) http://www.fws.gov/r5crc/pdf/CRASC_RH_restoration_plan_Feb_10_2015.pdf
- Coordinated and served as lead writer for CRASC - American Shad Status Report, approved by CRASC at June 2015 meeting http://www.fws.gov/r5crc/pdf/CRASC_Shad_Status_Report_June_2015_Final.pdf
- Coordinated multi-agency American shad population model meetings with NOAA technical staff and partners
- Coordinated/completed cooperative agreements with consultants for both main stem power company owners, for shad tank truck use, to complete components of FERC American shad telemetry studies
- Assisted in coordination among CAFRC research project, NOAA research project, and power company's consultants FERC shad studies, on shad field research and activities during 2015
- Initiated the revision effort for the CRASC Connecticut River Basin American Shad Management Plan

Technical Assistance

- Completed downloading and servicing of all water temperature loggers through the main stem river
- Removed shad tank and equipment from 1985 Ford truck (gov. auction), replaced 1,100gal shad tank with smaller 800gal tank on International and re-outfitted that truck. New International truck, arrived in 2015, was set-up with the larger 1,100gal tank. Both trucks were used for shad, river herring, and sea lamprey transfers in spring
- Participated in numerous hydropower federal relicensing meetings, reviewed reports, data, assisted with written responses, provided consultant study guidance and study coordination over the full course of the year for both FirstLight Power and TransCanada (5 main stem projects)
- Completed Annual Sport Fish Restoration Grant Report for FY14
- Fall River (Gill/Greenfield, MA) dam removal was completed in December 2014, under partnership of USFWS (*Martha Naley*) and MA Division of Ecological Restoration
- Stoney Brook (Suffield, CT), Karp Family dam was removed in January 2015, under partnership of USFWS (*Phil Herzig*) and CTDEEP
- Completed additional analyses of 2011 and 2012 American shad migration study and developed a presentation given at CRASC Research Forum (March 2015) on these results for lower river tagged shad
- Completed "Adult River Herring Population Assessment Survey Protocols for the Connecticut River Basin River"
- Examined a total of 716 blueback (BBH) and 221 alewife (ALE) otoliths (ear bone) samples from 2014
- Cleaned and slide mounted stored scale samples from 716 BBH and 221 ALE, from lab processed fish in 2014, examinations for spawning history were initiated

- Conducted river herring population assessment surveys on 20 dates from April 9, through June 4, 2015, at seven standard sample location
- Processed in the field a total of 1,448 BBH herring and 258 ALE for biological data, during spring 2015 river herring population surveys
- Processed in laboratory a total of 622 BBH and 165 ALE, subsampled and retained from field (e.g., otolith extractions) in 2015



Alewife (top) and blueback herring

- Cleaned and slide and mounted scale samples from all 2015 lab processed river herring (N = 787)
- Provided tissue samples for East Coast genetic study as requested (N = 68 for BBH and N = 113 ALE)
- Served as a USFWS member to Northeast Regional Agency River Herring Team, provided updates on population assessment activities, attended meetings
- Processed American shad for fish health testing completed by USFWS Northeast Fish Health Center (NFHC) from Holyoke Fish Lift
- Captured American eel by electrofish sampling from three locations for fish health tests completed by USFWS NHFC
- Served as member on the USFWS Connecticut River Pilot for the Landscape Conservation Cooperative and its aquatic team
- Served as USFWS advisor to CTDEEP for their State Wildlife Action Plan update
- Participated in CRASC Sea Lamprey Subcommittee on Plan development
- Served as USFWS member to ASMFC Shad and River Herring Technical Committee participated in meetings during year
- Provided program information and requested data to cooperators, researchers, and the public
- Provided presentations on Connecticut migratory fishes status, management, restoration to Westfield State University (WSU), Northfield Mount Hermon School, Great Falls Middle School, and Friends of Conte Refuge. Secured and supervised two student intern (WSU), and a University of New Hampshire student volunteer. Participated in the Connecticut River Watershed Council Clean-up with office boat. Managed one Student Conservation Association Intern and organized and directed other volunteers and staff.
- Captured by boat electrofishing 2,770 blueback herring that were transferred to the Oxbow and Manhan River, Easthampton, MA and to the Farmington River, upstream of Rainbow Dam (with CTDEEP)
- Transferred 135 American shad to the Ashuelot River (NH), 45 to the Mattabesset River and 50 to the Farmington River (CT) from Holyoke Fish Lift supporting partners efforts
- Transferred a total of 102 sea lamprey from Holyoke Fish Lift to habitat upstream of the dam removal in the Fall River (Gill, MA)
- Conducted sea lamprey nest surveys in Massachusetts in the lower Green River, Fall River (above and below removed dam), lower Sawmill River, target reaches of the Manhan River and in Stoney Brook, CT (above and below removed dam).
- Cleaned and mounted adult sea-run Atlantic salmon scales; read scales for age determinations
- Maintained adult Atlantic salmon return and stocking databases, and fish transfers database

- Maintained fish passage (counts) databases, provided data for several requests
- Entered data from all fish population assessment work and transfers into databases or spreadsheets and conducted summary analyses
- CRC Office grant agreements were completed and managed by USFWS staff for habitat restoration projects noted earlier and including additional culvert replacements and a small dam removal in the Westfield River basin with Trout Unlimited using two grant agreements.

Acknowledgements

I would like to thank the many people who have contributed to the accomplishments that are contained in this annual report, my Office Assistant, Darleen Cutting (retired at the end of September 2015) and Darren Desmarais (Office Fish Biologist) performed many important functions this report period. Phil Herzig, co-located at this office made important contributions on the fish tank rehab/set up work that involved three trucks and managing habitat projects including the removal of Karp Dam on Stoney Brook (Suffield, CT).

Beth Alger, Student Conservation Association intern, Shelby Scarfo (UNH student), and interns Joe Boulia and Kyle Morton and Conte Refuge SCA interns (Evan, Elena, Barrett, and Erika) with other volunteers, increased effort, productivity, and quality of work.

USFWS staff assistance came from Martha Naley, who led the completion of the Fall River Dam removal and Melissa Grader who operated the Manhan River fish ladder and its fish count monitoring. John Warner and Melissa Grader provided important leadership in meetings, correspondences, and coordination, for the FERC five main stem relicensing process. Brett Towler provided critical fish passage engineering expertise on FERC studies and Holyoke Downstream designs, and other activities including fishway inspections at facilities.

Bill McDavitt (NOAA) provided expertise on fish passage and habitat matters and support for the Shad Population Modeling effort. The Conte Anadromous Fish Research Center continued to provide ongoing technical expertise on many fish passage issues, with FERC relicensing study plans, Shad Population Model development, and shortnose sturgeon topics (Theodore Castro-Santos, Alex Haro, Micah Kieffer, Steve McCormick). Don Pugh (Trout Unlimited) provided important input and contributions on FERC relicensing matters and Population Model discussions. Katie Kennedy (Nature Conservancy) also provided important contributions on FERC relicensing study designs and other restoration work. Amy Singler (American Rivers) and Alex Hackman (MA Department of Ecological Restoration) provided expertise and leadership on dam removals.

The Sport Fish Restoration Grant money provided by the states of Connecticut, Massachusetts, Vermont, and New Hampshire, through F-100-R, are administered by the Wildlife Sport Fish and Restoration Program at USFWS with the appreciated assistance of the following Grant Coordinators; Tony Petrillo (CT), Kris McCarthy (MA), Randy Curtis (NH), Steve Gomez (VT), and Jen Stone (USFWS).

Other thanks for assisting in the accomplishments over this report period go to:

State fishery agencies -

- Connecticut: Steve Gephard, Dave Ellis, Tim Wildman, Jacque Benway, and staff
- Massachusetts: Caleb Slater, Ben Gahagan, and Scott Elzey and lab staff
- New Hampshire: Matt Carpenter and Gabe Gries
- Vermont: Lael Will and Ken Cox

The Connecticut River Watershed Council, under the direction of Andrew Fisk and his staff, continue to provide important support in many ways to Fisheries priorities including FERC relicensing involvement (Andrea Donlon), field activities, and fish habitat restoration and passage projects.

The Anadromous Fish Program and The Connecticut River Atlantic Salmon Commission

The administration of the interjurisdictional cooperative effort to restore diadromous fish species, to the Connecticut River basin is accomplished through the Connecticut River Atlantic Salmon Commission (the Commission). During the period from 1967-1983 (prior to the Commission), restoration of anadromous fish, primarily Atlantic salmon and American shad, on the Connecticut River was guided by the Policy Committee and the Technical Committee for Fisheries Management of the Connecticut River Basin. The importance of this formally-structured, coordinating and regulatory body to the restoration program was recognized in 1983 when Congressional consent was given to the Connecticut River Basin Atlantic Salmon Compact, Public Law 98-138. The enabling legislation was re-authorized for another 20 years in 2002. This law, originally passed by the legislative bodies in each of the four basin states, created the Commission and conveys Congressional support to an interstate compact for the restoration of anadromous fish to the Connecticut River Basin. The Commission is comprised of ten Commissioners (Table 1) including a high-level government employee and a public sector representative appointed by the governor of the appropriate state, and the Northeast Regional Directors of both the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS).

The Commissioners act on policy matters and are advised on scientific and technical matters by a Technical Committee. The Technical Committee is comprised of senior staff biologists from each Commission member agency, the U.S. Forest Service (USFS), and the Massachusetts Division of Marine Fisheries (Table 2). The Technical Committee has nine subcommittees, with specific areas of responsibility (American Shad, River Herring, Atlantic Salmon, American Eel, Sturgeon, Sea Lamprey, Fish Passage, Habitat, and Fish Culture). Other experts and cooperators from the member agencies including the U.S. Geological Survey, Conte Laboratory, Trout Unlimited, The Nature Conservancy, Connecticut River Watershed Council, and private industry, and others participate with the subcommittees and Technical Committee as needed. The Connecticut River Coordinator (Coordinator), an employee of the USFWS, acts as the

Executive Assistant to the Commission and the Secretary for the Technical Committee and in June 2015 also became the USFWS Technical Committee representative.

The Coordinator, as titled, is responsible for coordination of state and federal activities, providing technical expertise, project development and implementation of fish population assessments, restoration and management programs at the population and habitat level, program evaluation, regulatory input through Federal Power Act with FERC, and advocacy and outreach of the multi-agency cooperative diadromous fish restoration program in the Connecticut River watershed (Figure 1). The Coordinator also organizes meetings, identifies priorities, develops initiatives and plans, implements them, and maintains and develops partnerships to accomplish objectives.

Fish species under restoration and enhancement in the Connecticut River basin include American shad, blueback herring, sea lamprey, American eel, and alewife, primarily addressed by efforts to provide upstream and downstream passage to historic habitats. Shortnose sturgeon, the only federally endangered species population (under recovery), continues to be monitored, studied, and protected through various mechanisms. Atlantic sturgeon is considered extirpated from the river, but the remaining East Coast populations were designated as federally endangered by NMFS in 2012, the most closely identified extant population to this river being the Hudson River.

In 2015, adult salmon entering fishways with trap facilities were examined and given a visible streamer tag and passed upstream, with a small portion taken to CAFRC for swimming performance studies before being released after < 2 day retention. Assessments of returning adults will continue, providing data for CRASC and the U. S. Atlantic Salmon Assessment Committee work. Atlantic salmon are expected to be a management topic requiring coordination through CRASC for likely the next few years, based on the last (final) large scale stocking occurring in 2013, concluding the restoration effort. The CRASC continues to serve as an important mechanism to maintain communication and coordination on migratory fish restoration and management activities in the Connecticut River basin. Given the current status of main stem hydro facilities in FERC relicensing process and recent Holyoke Dam downstream passage settlement measures, the need and value of a basin-wide management approach is as important as it has ever been.

Vice Chair Wayne MacCallum receives a plaque of appreciation for his many years of service to CRASC, at his last meeting on December 2014.

The CRASC meets at least twice each year and the Technical Committee meets as frequently as needed. This report period, the Commission met on December 11, 2014 and on June 15, 2015. The Technical Committee met on November 3, 2014 and June 10, 2015. At the December 11, 2014 meeting Vice Chair Wayne MacCallum announced his retirement. His decades of service to the CRASC and dedication to the restoration of migratory fishes, was recognized and appreciated by his peers. Dr. Jack Buckley was promoted as the Massachusetts Director of Fisheries and Wildlife and became the Massachusetts Agency Representative. CRASC scheduled meetings are open to the public. Interested citizens are given the opportunity to provide input into the decision-making process and area news publishers are notified of scheduled Commission meetings. Minutes of both Commission and Technical Committee meetings are produced and distributed by the Coordinator's Office once approved. Approved Minutes were posted on the Connecticut River Coordinator's Office website. In addition to serving as an historic record, these minutes describe the progress and status of many coordinated activities.

Table 1. Connecticut River Atlantic Salmon Commission Membership (as of November 2015).

Connecticut River Atlantic Salmon Commission	
Federal	**U.S. Fish and Wildlife Service** *Wendi Weber* Regional Director, Region 5 *Sherry White, alternate*
	National Marine Fisheries Service *John Bullard* Northeast Administrator *Daniel Morris, alternate*
Connecticut	**Connecticut Dept. of Energy and Environmental Protection** *William Hyatt (Chair)* Chief, Bureau of Natural Resources *Stephen Gephard, alternate*
	Public Sector Representative *Robert A. Jones*
Massachusetts	**Massachusetts Division of Fisheries and Wildlife** *Jack Buckley (Wayne MacCallum retired 2015)* Director *Mark Tisa, alternate*
	Public Sector Representative *Andrew Fisk (Vice Chair)*
New Hampshire	**New Hampshire Fish and Game Department** *Glenn Normandeau* Executive Director *Scott Decker, alternate*
	Public Sector Representative *Duncan McInnes (new term in review)*
Vermont	**Vermont Department of Fish and Wildlife** *Louis Porter* Commissioner *Eric Palmer, alternate*
	Public Sector Representative *Peter H. Basta*

Table 2. Connecticut River Atlantic Salmon Commission Technical Committee Membership.

Connecticut River Atlantic Salmon Commission Technical Committee	
Federal	**U.S. Fish and Wildlife Service** *Kenneth Sprankle*
	National Marine Fisheries Service *William McDavitt*
	U.S. Forest Service *Dan McKinley*
Connecticut	**Connecticut Dept. of Energy and Environmental Protection** *Stephen R. Gephard*
Massachusetts	**Massachusetts Division of Fisheries and Wildlife** *Caleb Slater* (Chair)
	Massachusetts Division of Marine Fisheries *Ben Gahagan*
New Hampshire	**New Hampshire Fish and Game Department** *Matthew Carpenter*
Vermont	**Vermont Department of Fish and Wildlife** *Lael Will*

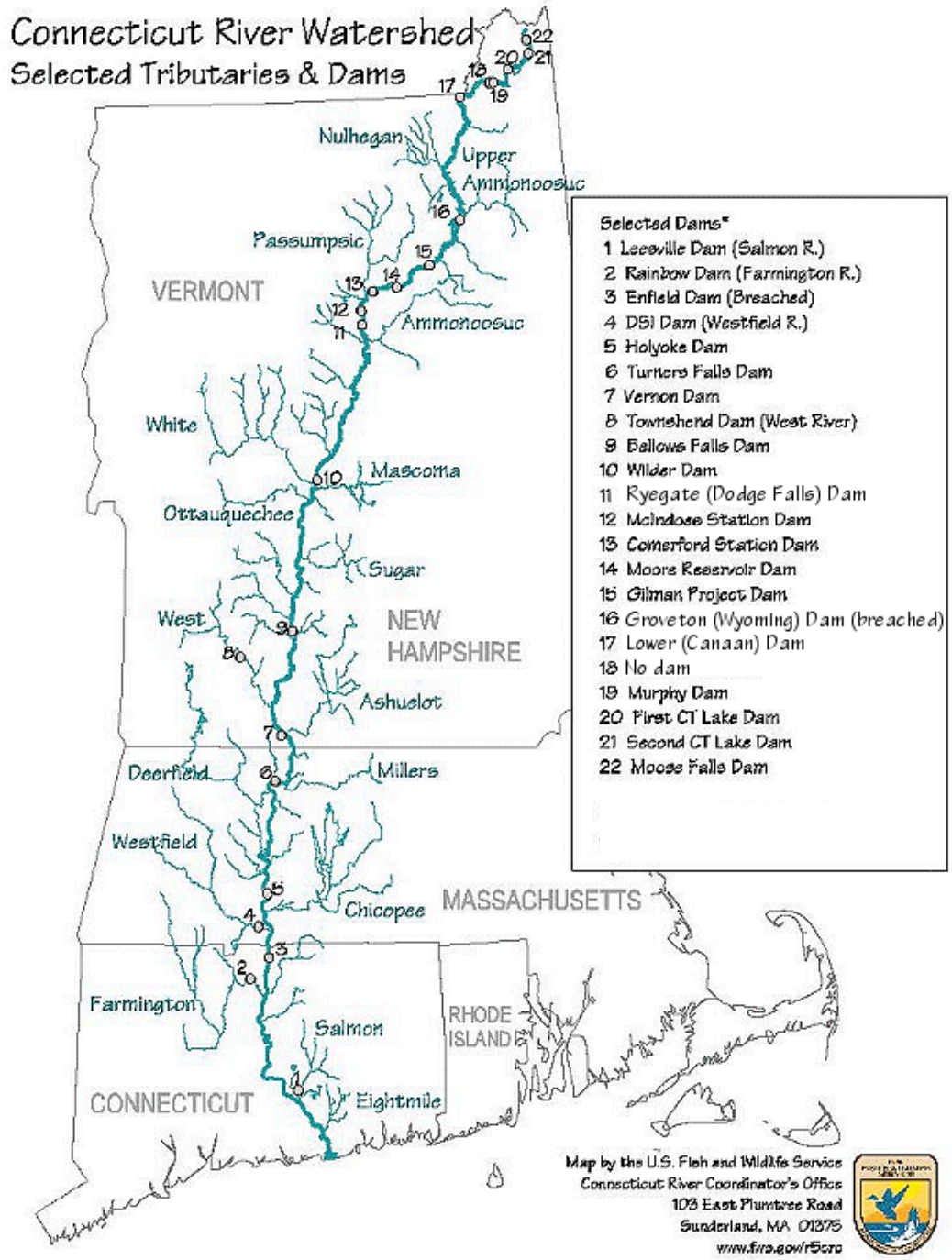


Figure 1. Connecticut River basin with major tributaries and main stem dams shown.

Coordination and Technical Assistance Funding

The Connecticut River Coordinator's (CRC) Office, under the USFWS' Wildlife and Sport Fish Restoration Program's F-100-R-32, received $20,000 from the four state fishery agencies to coordinate activities and provide technical assistance through the state's annual Sport Fish Restoration Program apportionment (F-100-R). The grant project was assessed an USFWS administrative overhead fee (18%) leaving $16,393 available. The CRC Office utilized the Sport Fish Restoration funds, Fisheries Program base funding and fish passage and habitat restoration funding/grants that totaled $390,084.84 for facility and program operations (of which $56,695.00 was for three habitat grant projects). In 2015, the majority of the State's Sport Fish Restoration funds were used to purchase a new, insulated, 990 gallon, circular fish transport tank that will be installed on the new flatbed truck obtained in 2015 at cost of $13,560.00, with the balance assisting in operational costs.

Station total: $390,084.84 **States (F-100-R):** $16,393.44 **Federal:** $373,691.40

Project Accomplishments

The Connecticut River Coordinator's Office enhanced the Commission's and States' ability to manage, evaluate, and implement restoration programs through a variety of activities and accomplishments some of which are described in greater detail here in the following section. Please note that data presented in this report has been reviewed to the extent possible, but is subject to change and should be considered provisional. **Use of any presented data should be discussed with the Coordinator to avoid potential issues with use, analyses, and/or interpretation**.

Coordination activities, select details:

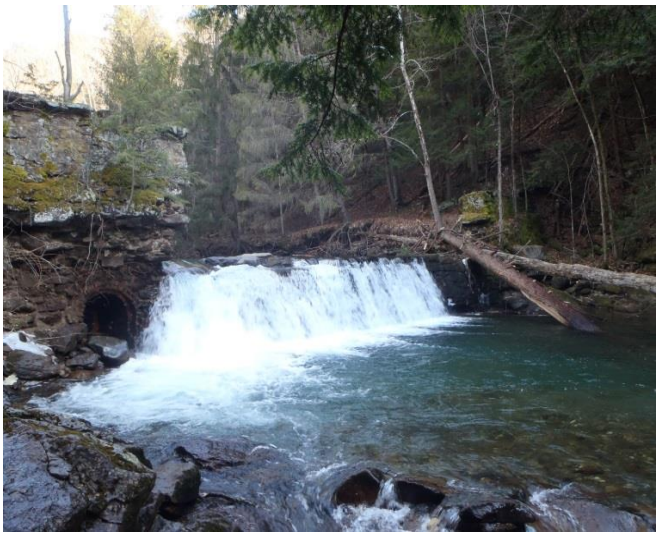
- The Coordinator continued to provide administrative support to the Commission and Technical Committee as the Executive Assistant and Secretary respectively, making meeting arrangements, assisting in setting agendas, developing reports, distributing information, finances, and recording and distributing minutes of Commission and Technical Committee meetings (four in the report period). The Coordinator participated on the CRASC Fish Passage, Shad and River Herring, Sea Lamprey subcommittees during this report period. The Coordinator served as the Chair for Shad and River Herring subcommittees and issued the Annual Fish Passage Notification letters on behalf of CRASC to main stem hydropower operators.

- The Coordinator developed the CRASC Technical Committee Research Forum that was held on March 3, 2015 at the Massachusetts Division of Fisheries and Wildlife Headquarters. The agenda included 11 platform presentations on a diversity of topics, was open to the public and was attended by approximately 65 state, federal, academic, private, biologists, non-government organizations and the public. The Coordinator developed and presented at this forum the results from tagging studies with American shad in 2011 and 2012 in the lower river and their movement and passage at Holyoke Dam.

- The Coordinator worked with Connecticut Department of Energy and Environmental Protection (CTDEEP), New Hampshire Fish and Game (NHFG), Rhode Island Division of Fish and Wildlife (RIDFW), U.S. Geological Survey, Conte Lab (USGS), and Holyoke Gas and Electric fishway staff to develop a shad trap and transfer schedule for the Holyoke Fish Lift, summary of transfers provided in this report.

Ed Bills Pond Dam removal, Eightmile River, Lyme CT, initiated in fall of 2015 with impoundment draw down shown in above image.

- The Coordinator's Office, partnering with many other agencies and NGO's to provide funding support for the removal of the Ed Bill's Pond Dam, as well as financial and substantial technical support for the Falls River Dam removal (Greenfield/Gill, MA), overseen by Martha Naley (USFWS).



Fall River dam removal, Greenfield/Gill, MA, completed in December 2014.

Fisheries Management, Restoration, Assessment, and Technical Assistance, additional select information:

- The Coordinator conducted for the third year, a large scale population assessment program for river herring that was initiated in early April, utilizing boat electrofishing as the primary sampling gear. Study objectives are to: 1) obtain a minimum whole fish sample of 50 blueback and alewife for age structures, per target sample location; 2) obtain baseline demographic data on all sampled herring (species, length, weight, sex); 3) derive relative abundance measures; 4) conduct surveys across a broad geographic range of spawning aggregations and over the duration of the runs (April-June), to represent spatial and temporal variations for both species; and 5) determine fish ages from otoliths and spawning history from scale examinations; utilize standard stock assessment procedures and statistics. This work was conducted to address identified priority data needs, specific to the Connecticut River and coast-wide, as described in the Atlantic States Marine Fisheries Commission's River Herring Benchmark Stock Assessment Report released in May 2012 (http://www.asmfc.org/uploads/file/riverHerringBenchmarkStockAssessmentVolumeIR_May2012.pdf). This assessment work is a long-term commitment by the office and will continue in future years. The assessment is intended to provide the varied data requirements and subsequent analyses required for responsible science-based restoration and management of these species in the future.

  A USFWS "Adult River Herring Population Assessment Survey Protocols for the Connecticut River Basin River" manual was produced in December 2014. In 2015 surveys were conducted on a total of 20 dates. Seven targeted sampling areas consisted of the Salmon River (Haddam CT), lower Mattabesset River (Middletown CT), Wethersfield Cove (Wethersfield CT), lower Farmington River (Windsor, CT), lower Westfield River (Agawam MA), main stem in Springfield MA, and lower Chicopee River (Chicopee MA)[Figure 2].

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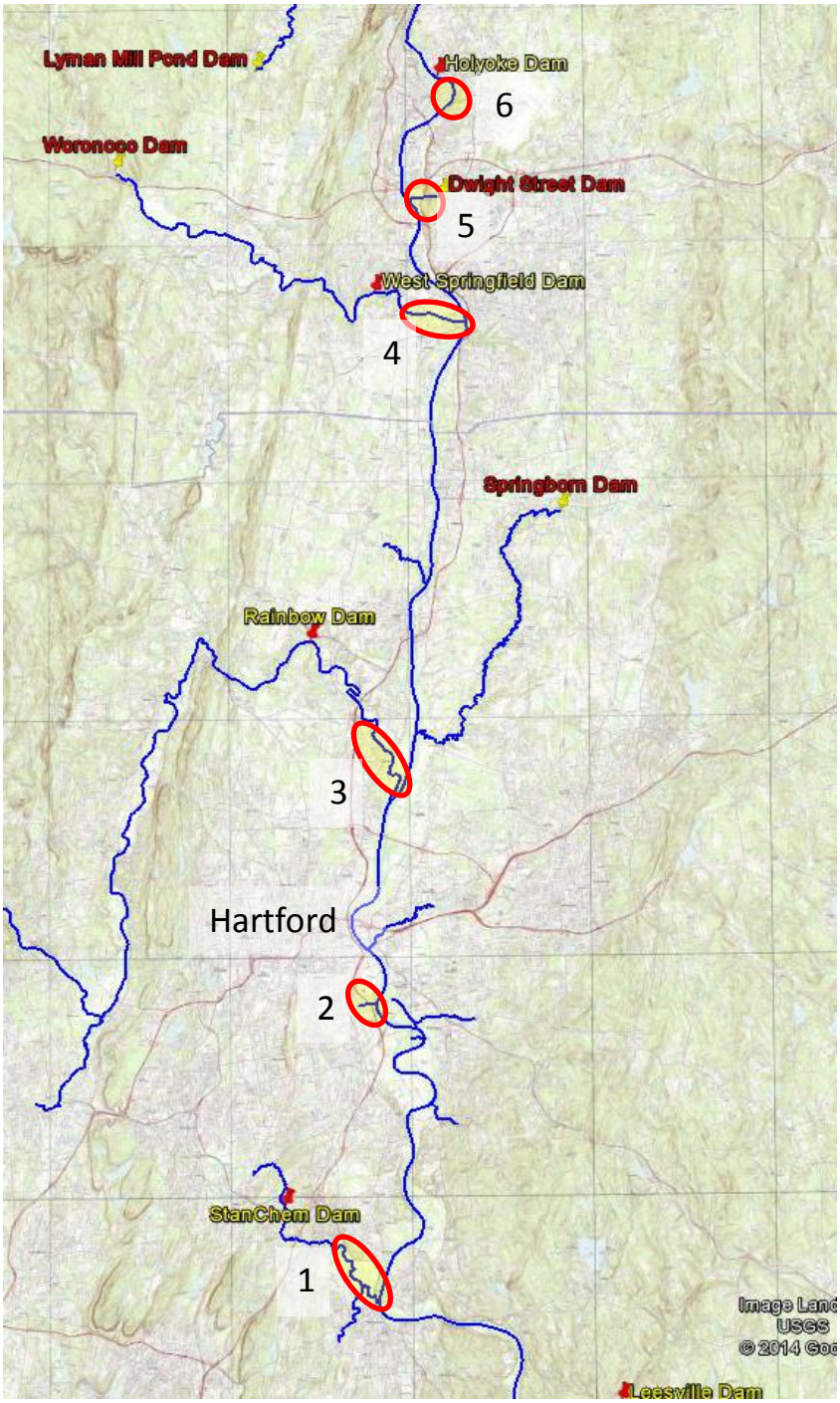

Figure 2. Adult river herring population assessment field sampling locations:
1) Mattabesset River; 2) Wethersfield Cove; 3) Farmington River;
4) Westfield River; 5) Chicopee River; 6) Downstream of Holyoke Dam
(Images from/using Google Earth)

Otoliths and scales were cleaned and stored, with all field data entered into a database. Individual fish samples and records are all uniquely labeled. Some summary analyses for the data obtained 2013 – 2015 are shown in Table 3 and described in the following narrative.

Overall, USFWS river herring population assessment effort was consistent with 2014 but

reduced catch rates for blueback herring reflect a likely reduction in relative run size in 2015 compared with 2014 (Table 3).

Table 3. Selected sampling statistics comparing USFWS river herring population assessments for 2013 - 2015.

	2015	2014	2013
Number of sampling dates	20	21	18
Total sample runs	114	124	81
Total Efishing seconds	56,025	55,736	41,177
Total bluebacks captured	1,448	2,593	714
Total alewives captured	258	220	107
Blueback herring oto/scale - lab	622	655*	501*
Alewife oto/scale - lab	165	188*	103*

*****single reader, all otoliths read and rated

A total of 114 timed sampling runs were completed over the 20 sample dates, covering 27 target sample areas. There was a single date/occasion of a sample run not constrained to 500 seconds, in the main stem river in Springfield MA, but was standardized for a relative abundance index value. Sampling began on April 9, 2015 and ended on June 4, 2015 and included areas ranging from the Salmon River (Haddam, CT) to as far upstream as the Chicopee River (Chicopee, MA). Water temperatures were relatively cold in April and will be described with later data plots that delayed river herring arrivals compared to the previous two years. In 2015, for sample runs that produced BBH, the mean of those runs (N = 49) had an average catch rate of 3.4 (± 3.8 SD) fish/min. This is a decrease for the same measure in 2014, of 9.9 (± 13.4) fish/min and close to the measure in 2013, of 2.8 (± 6.1) fish/min. The high variability of these data, as reported at this time, precludes statistical testing for differences in rates. Catch rates and fish processed for data are on occasion different values, as large run catches are subsampled for biological data, while the remainder of the catch is only counted and released for that run (only used for run catch rate statistics). Statistical analyses of the relative abundance data/rates remains to be conducted but are expected to follow the standard approach of using geometric mean values to address the inherent high variability of this data, similar to juvenile fish seine catch data.

A plot of individual run catch rates for blueback herring is shown in Figure 3 to illustrate the level of variability among runs and through time. The apparent lack of sampling points reflects repeated runs of zero catch, primarily for early sample dates. The figure also compares 2013 to 2015 catch rates, by date alone (timing only), noting that sites sampled varied among years along the x axis. The figure illustrates that catch rates were substantially greater in 2014 for blueback herring and that in 2015 catch rates were reduced to levels fairly consistent with 2013. Multiple sample runs can be represented by a single point, primarily when zero catches occurred early or late in the year.

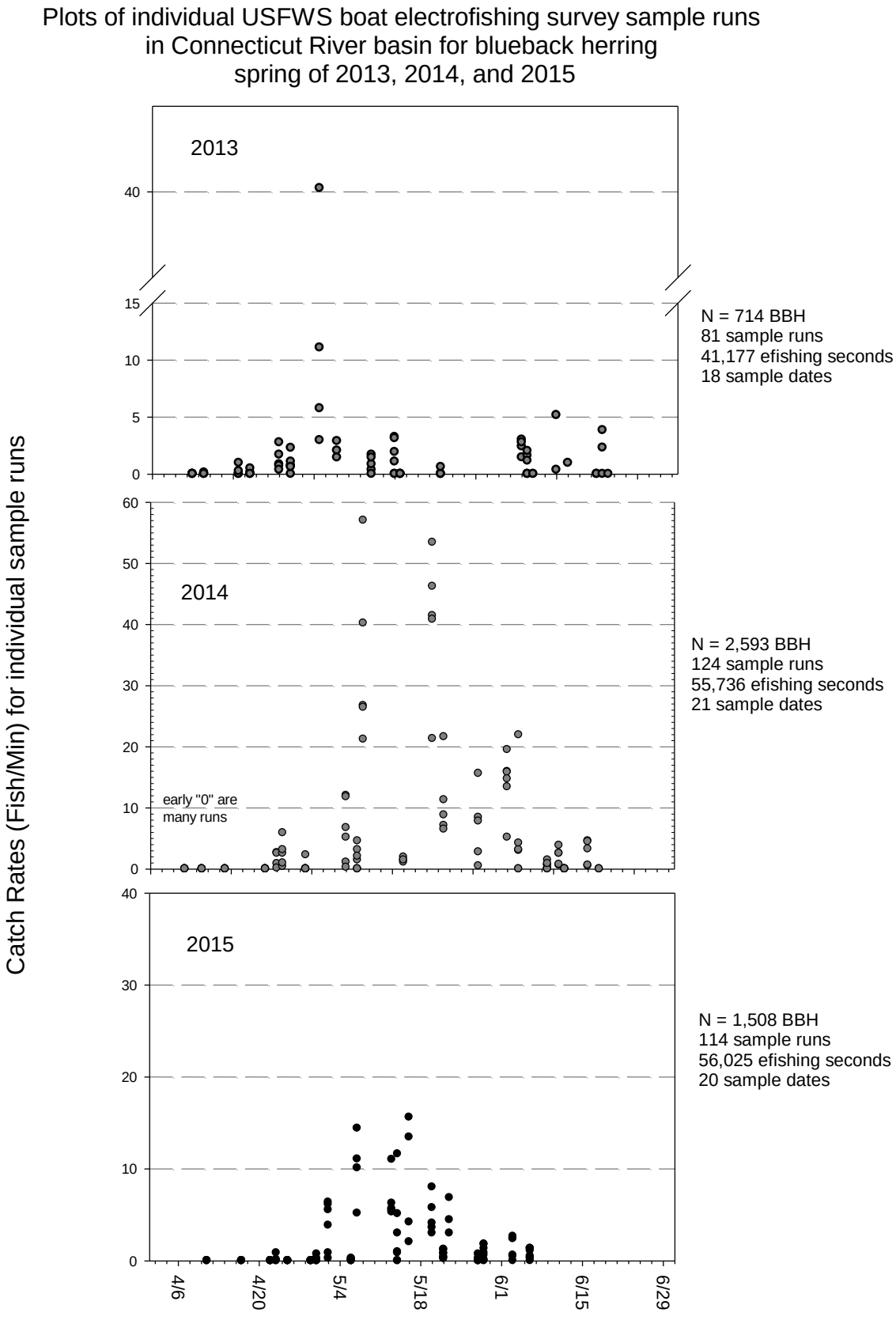

Figure 3. Catch rates of blueback herring reported as fish/min for individual sample dates, over time, not incorporating variation in sample sites among the years over time.

- Reading of all alewife and blueback herring otolith samples obtained in 2014 was completed by a single reader in 2015. Ideally there would be a second blind read to compare age assignments, but having a single staff biologist makes this unlikely given the Coordinator's other duties. A summary of mean total lengths (mm) with standard deviations are shown in Table 5, by sex, for both species, for the study period. A one-way ANOVA detected significant differences ($P < 0.001$) among annual mean total lengths for both male and female blueback herring and alewife. Post-hoc pairwise comparisons (Holm-Sidak) detected significant differences at $P < 0.05$ as indicated in Table 4, for same species and sex by year.

Table 4. Summary of mean total length (mm) with standard deviations (SD), for all processed blueback and alewife, by sex, for the survey years of 2013 – 2015. ANOVA tests were followed by pairwise comparisons by species and sex. Significantly different pairwise comparisons ($P < 0.05$) are indicated by year letter assignment.

	Blueback				**Alewife**			
	Male		Female		Male		Female	
Year	Mean TL mm (± SD)	Signf. Diff.	Mean TL mm (± SD)	Signf. Diff.	Mean TL mm (± SD)	Signf. Diff.	Mean TL mm (± SD)	Signf. Diff.
2013[A]	253.8 (12.1)	C	264.9 (12.6)	C	261.6 (15.8)	B, C	287.7 (16.2)	B
2014[B]	253.8 (11.4)	C	264.9 (13.2)	C	266.2 (10.8)	A, C	276.1 (15.5)	A, C
2015[C]	263.0 (10.4)	A, B	277.8 (11.7)	A, B	273.1 (11.7)	A, B	287.9 (12.4)	B

- River herring population assessment data remains to be comprehensively analyzed and interpreted for a separate planned report. Examination of the fish data will include statistical tests to determine whether there are differences over time at survey sites (i.e. fish size). An examination of the 2015 Farmington River, BBH female total length mean, sampled on 5 dates, is shown in Table 5. A plot of the individual sizes, vs. date, examined by linear regression yields a $P = 0.256$. However, a one-way ANOVA using the data in Table 5 detected significant differences among groups, followed by pairwise comparisons (Holm-Sidak), results reported in Table 5. The proportion of females from the total sample by date was lowest on 4/30 (0.22) and greatest on 6/4 (0.60), mean female proportion all dates = 0.36 (± 0.15). The observation of larger fish arriving early will be more closely examined with age structures for the entire data set and has been reported in other systems.

Table 5. Mean total length (mm) with standard deviations (SD) for female blueback herring sampled from the Farmington River in 2015, by sample date. ANOVA test among groups ($P < 0.001$), was followed by post-hoc pairwise comparisons with significant differences identified.

Sample	Date	N	Mean TL mm (± SD)	Significant Differences ($P < 0.05$)
1	4/30	42	285.7 (10.1)	5/11, 5/27, 6/4
2	5/11	97	276.6 (11.0)	
3	5/18	45	281.1 (10.9)	[*vs. 5/11, P = 0.055*)
4	5/27	19	274.1 (12.3)	
5	6/4	31	276.7 (12.3)	

- The completion of otolith aging from all river herring in 2014 was used to explore age structure comparison for a single sample location between years. Examination of the

blueback herring age structure, by sex, for the Farmington River in 2013 and 2014, is plotted on Figure 4. Sample sizes between the two years varied and data are presented as percentage of sample by age and by sex. The substantial increase in the proportional contribution of both age-4 females and age-4 males to the population age structure in 2014 may be explained by two important observations, with management implications. First, there was a very high juvenile blueback herring index value reported by CTDEEP for their juvenile clupeid survey in 2010. Second, this office and CTDEEP transplanted a record number of pre-spawn blueback herring upstream of Rainbow Dam on the Farmington River in 2010; totaling 4,575 fish (refer to 2010 Annual Report). There is no way to definitively determine the origin of the age-4 cohort, as either due to the first, second, or some combination of the two sources at the time of this report. However, further planned analyses of the data, including the other survey area's age structure, and the 2015 age determinations, may provide hypothesis testing opportunities, as pre-spawn transfers did not occur in all sample areas. The future planned analyses may be used to help validate the CTDEEP juvenile alosine index and/or demonstrate by testing or weight of evidence, the effects of pre-spawn stockings for that year in the Farmington River.

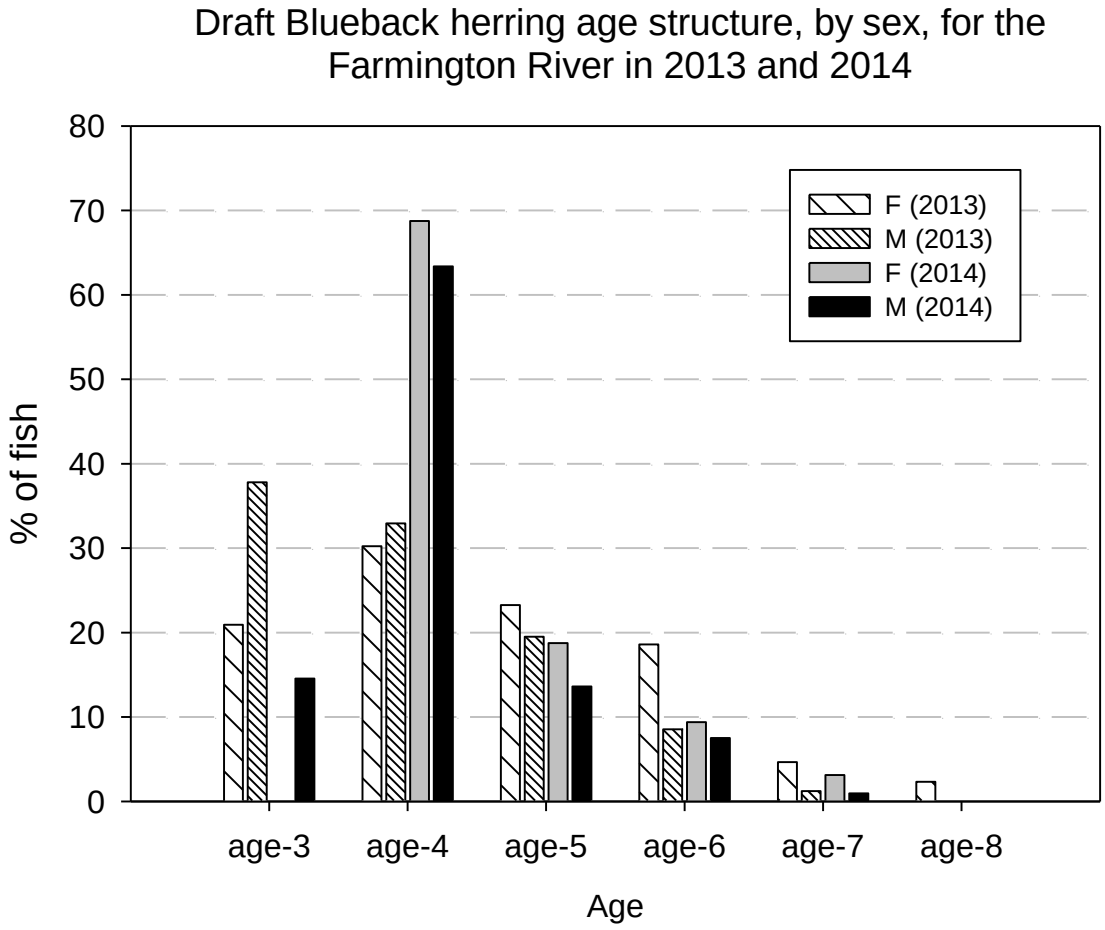

Figure 4. An example of blueback herring age structure assignments/summaries for the Farmington River, by sex (shown as F and M), for both 2013 and 2014 survey years.

- Active river herring restoration measures were initiated as blueback herring catch rates in population assessment work increased. In the month of May the Coordinator's Office transitioned to capture efforts for pre-spawn herring from Wethersfield Cove, concurrent with population assessments. Similar to the past three years, boat electrofishing was the primary capture gear for the 2,770 herring captured and transferred to accessible but unutilized habitats upstream of Holyoke Dam and the Farmington River (Table 6). This was a decrease from the 5,680 captured and moved in 2014. Fish were transported in two USFWS tank trucks with salt, diffused oxygen, and recirculating water pumps. The CTDEEP also transported blueback herring and assisted on other dates with captures.

Transfer of pre-spawn blueback herring from electrofish collections with CTDEEP.

Table 6. Data for blueback herring captured primarily by boat electrofisher from Wethersfield Cove, CT, and relocated for restoration in 2015.

Date	Number Moved	Mortalities	Release Location
5/7	1,360	50	Farmington River, Farmington, CT
5/8	650	8	Oxbow (Northampton/Easthampton), MA
5/14	270	0	Oxbow (Northampton/Easthampton), MA
5/21	200	3	Manhan River, Easthampton, MA
5/22	290	6	Manhan River, Easthampton, MA
Totals	2,770	67	

- A summary of American shad transfers from Holyoke Fish Lift to support restoration efforts in and out-of-basin, with stocking locations, and by agency are provided in Table 7. In addition CAFRC used shad for experimental fish passage approaches, with the subsequent release of these study fish immediately upstream of Turners Falls Dam.

Table 7. American shad trapped at Holyoke Fish Lift and transferred in 2015

Date	Species	Capture Location	Transported By	Destination Waterbody	Destination State	Number Transported	Number Released
13-May-15	Am shad	HFL	USGS	CONTE LAB/CT RIVER	MA	97	97
18-May-15	Am Shad	HFL	RIDFW	ASHUELOT RIVER	NH	76	76
18-May-15	Am shad	HFL	USGS	CONTE LAB/CT RIVER	MA	175	175
18-May-15	Am Shad	HFL	RIDFW	NANFH	MA	77	76
19-May-15	Am Shad	HFL	RIDFW	ASHUELOT RIVER	NH	75	75
19-May-15	Am Shad	HFL	RIDFW	NANFH	MA	75	73
20-May-15	Am Shad	HFL	RIDFW	ASHUELOT RIVER	NH	78	78
20-May-15	Am shad	HFL	USGS	CONTE LAB/CT RIVER	MA	218	215
20-May-15	Am Shad	HFL	RIDFW	NANFH	MA	76	75
20-May-15	Am Shad	HFL	CTDEEP	NAUGATUCK RIVER	CT	82	82
21-May-15	Am Shad	HFL	CTDEEP	NAUGATUCK RIVER	CT	80	76
26-May-15	Am Shad	HFL	CTDEEP	FARMINGTON RIVER	CT	80	78
26-May-15	Am shad	HFL	USGS	CONTE LAB/CT RIVER	MA	212	212
27-May-15	Am Shad	HFL	RIDFW	ASHUELOT RIVER	NH	75	75
27-May-15	Am Shad	HFL	CTDEEP	FARMINGTON RIVER	CT	80	80
27-May-15	Am Shad	HFL	RIDFW	NANFH	MA	76	66
28-May-15	Am Shad	HFL	CTDEEP	QUINNIPIAC RIVER	CT	80	80
28-May-15	Am shad	HFL	USGS	CONTE LAB/CT RIVER	MA	222	220
1-June-15	Am shad	HFL	USGS	CONTE LAB/CT RIVER	MA	214	214
05-Jun-15	Am Shad	HFL	USFWS	ASHUELOT RIVER	NH	50	50
05-Jun-15	Am Shad	HFL	USFWS	ASHUELOT RIVER	NH	85	85
09-Jun-15	Am Shad	HFL	CTDEEP	QUINNIPIAC RIVER	CT	86	86
10-Jun-15	Am Shad	HFL	USFWS	FARMINGTON RIVER	CT	50	50
10-Jun-15	Am Shad	HFL	CTDEEP	MATTABESSET RIVER	CT	84	84
11-Jun-15	Am Shad	HFL	USFWS	MATTABESSET RIVER	CT	50	45
11-Jun-15	Am Shad	HFL	CTDEEP	MATTABESSET RIVER	CT	80	80
							2,603

- Sea lamprey nest counts were conducted in late June with 71 nests counted downstream of Wiley-Russell Dam on the lower Green River (Greenfield, MA), a substantial increase from the 29 observed in 2014; compared with 84 (2011); 184 (2010); and 55 (2009). This reach is 0.9 km in distance. Downstream of the Manhan River Dam (Easthampton, MA) and the fish ladder, 13 nests were counted compared to 28 nests in (2014), 35 (2011) and 20 (2010). Upstream of the new ladder, 3.3 km was surveyed in the main stem and moving up the North Branch, only observing 5 nests compared with 72 for the same reach in 2014 (first year of ladder operation). In the lower Sawmill River (Montague, MA) a total of 34 nests were counted from the Book Mill site to immediately below the Meadow Rd, bridge. Lastly, a total of 44 nests were counted in the Fall River (Gill, MA) downstream of the natural cascade as compared to 30 nests (2014), 133

(2011) and 27 (2010) a distance of 1.5 km to the first barrier (planned for removal). Following transplant of 90 sea lamprey (upstream of the removed dam) 16 nests were counted covering ~ 3 km of habitat both upstream and downstream of the release site, including down to the old dam site and linking with the extent of lower survey.

- The Coordinator used S.O. Conte Refuge, Student Conservation Association (SCA) interns and students and volunteers over the report period to assist primarily on work from April through early summer. Two students completed formal internship programs through Westfield State University. One undergraduate from UNH volunteer full-time for May and June, making a significant contribution. One SCA intern was hired and worked full-time from May through end of August, making important contributions to the work reported here. A total of approximately 400 volunteer hours, along with USFWS personnel from other offices/programs were essential to achieving project/program objectives.

- The Coordinator spent a significant portion of time on the FERC relicensing process for the Turners Falls Dam and Northfield Mountain Pumped Storage (NMPS) Project operated by FirstLight Power and TransCanada's Vernon Dam, Bellows Falls Dam, and Wilder Dam. The 5 year process (all licenses expire in 2018) was initiated in fall of 2012 and requires attention throughout the year. The CRC web site (http://www.fws.gov/r5crc) provides links to both FirstLight and TransCanada's web sites where documents for this process are posted.

  In this period, meetings to further define study plans by the companies and consultants continued, meetings in person and conference calls occurred over the course of the year. Review of documents, research and summary to support agency positions, and planning by agencies/partners, followed by interaction with company and consultants, were standard procedures. Topics covered included developing formal and informal written responses on study designs, review and comments on preliminary results, coordination on timing of activities based on real-time river conditions and ongoing reactive evaluations to issues and situations. Study examples include different movement/passage studies for shad (adult and juveniles), eel, sea lamprey, aquatic habitat studies, population studies, spawning studies and surveys, operational reports and analyses, and fishway studies.

- The Coordinator cleaned and slide mounted adult sea-run Atlantic salmon scale samples. The Coordinator worked with Steve Gephard (CTDEEP) in the aging of salmon scales and developing the 2015 adult run summary data (details in later section).

- The Coordinator maintained long-term temperature loggers (n=18) from Old Lyme, CT upriver to Wilder Dam, (VT/NH) in August and September of 2015, first deployed in the fall of 2009. Loggers record year-round at 20 minute intervals. Data from these loggers were used in later figures as an additional plotted variable with shad passage at Holyoke as well as for partner researcher use (NOAA/NMFS and USGS Conte).

Outreach

- The Coordinator's Office updated the station website on the Internet (http://www.fws.gov/r5crc) with current information and activities. Replied to ongoing request for fish count data, river herring data, and temperature data.

- The Coordinator's Office continued to maintain databases on migratory fish restoration activities. Daily fish counts at different dams were entered into a database by Office staff. Fish counts were updated regularly daily to every few days during the spring run, with email notifications to individuals and postings to the Coordinator's web site.

- The Coordinator gave presentations on migratory fish restoration, status and trends, to Westfield State University, Westfield, MA; Northfield Mount Hermon School, Gill, MA; Great Falls Middle School, Turners Falls; and Friends of Conte Refuge.

Program Results

The Connecticut River Coordinator's Office collected and reported information relating to the activities and accomplishments occurring in the Connecticut River basin diadromous fisheries restoration program. Note some of the data presented here are preliminary.

Migratory Fish Returns

American Shad - A total of 416,355 adult American shad were counted in 2015 at all passage facilities (first barrier) in the basin. A total of 412,656 shad were passed upstream of the fish lift in Holyoke, Massachusetts in 2015 (Figure 5). The long-term (1976-2014) mean shad passage count for Holyoke is 306,385 (±SD 131,987). The 25th percentile value for passage counts is 192,668 and the 75th percentile value for passage counts is 372,520. The shad passage count at Holyoke Fish Lift, as population metric with a number of caveats, has for the fourth year in a row been relatively strong for that data time series.

A total of 3,383 shad were passed upstream of the West Springfield Project in 2015 on the Westfield River which is a 30% decrease from 2014, but consistent with that ladder's long-term mean annual passage of 3,251, but well below its record 10,300 passed in 2012. A total of 316 shad were passed upstream of the Rainbow Dam Fishway on the Farmington River in Connecticut, a fishway with known issues for passing both shad and river herring.

Of the shad passed upstream of the Holyoke Dam, 58,079 shad were counted passing the Gatehouse fishway at Turners Falls Dam in 2015 (Table 8). The Turners Falls Dam and power canal is a three fishway complex. Fish must pass either the Cabot Station Ladder (into the power canal) or the Spillway Ladder (at the base of the dam), before having the opportunity to enter the Gatehouse ladder (or in the case of the Canal, the opportunity to use one of two entrances to enter the Gatehouse ladder). Overall, the 2015 passage number at Gatehouse ladder as a percentage of shad passed at Holyoke is 14.1%, a record value in the time series, but still well below the agencies' management plan target. The CRASC, Shad Management Plan has an objective of 40-60% shad passage at each successive barrier on the main stem. Vernon Dam fishway set **a new shad passage record for that facility (37, 771 passed)**, breaking the previous record set in 1992 (facility began operation in 1981). Vernon Dam fishway passed 68.5% of the shad counted passing from Turners Falls Gatehouse ladder (Table 8). Results from radio and PIT tagged American shad movement and passage at these dams and their fishways, for both up and downstream passage as well as survival, remain under analyses by the power company

consultants, including the various treatment spill and operation treatments developed by the agencies to examine fish responses to different operational conditions (FERC relicensing studies).

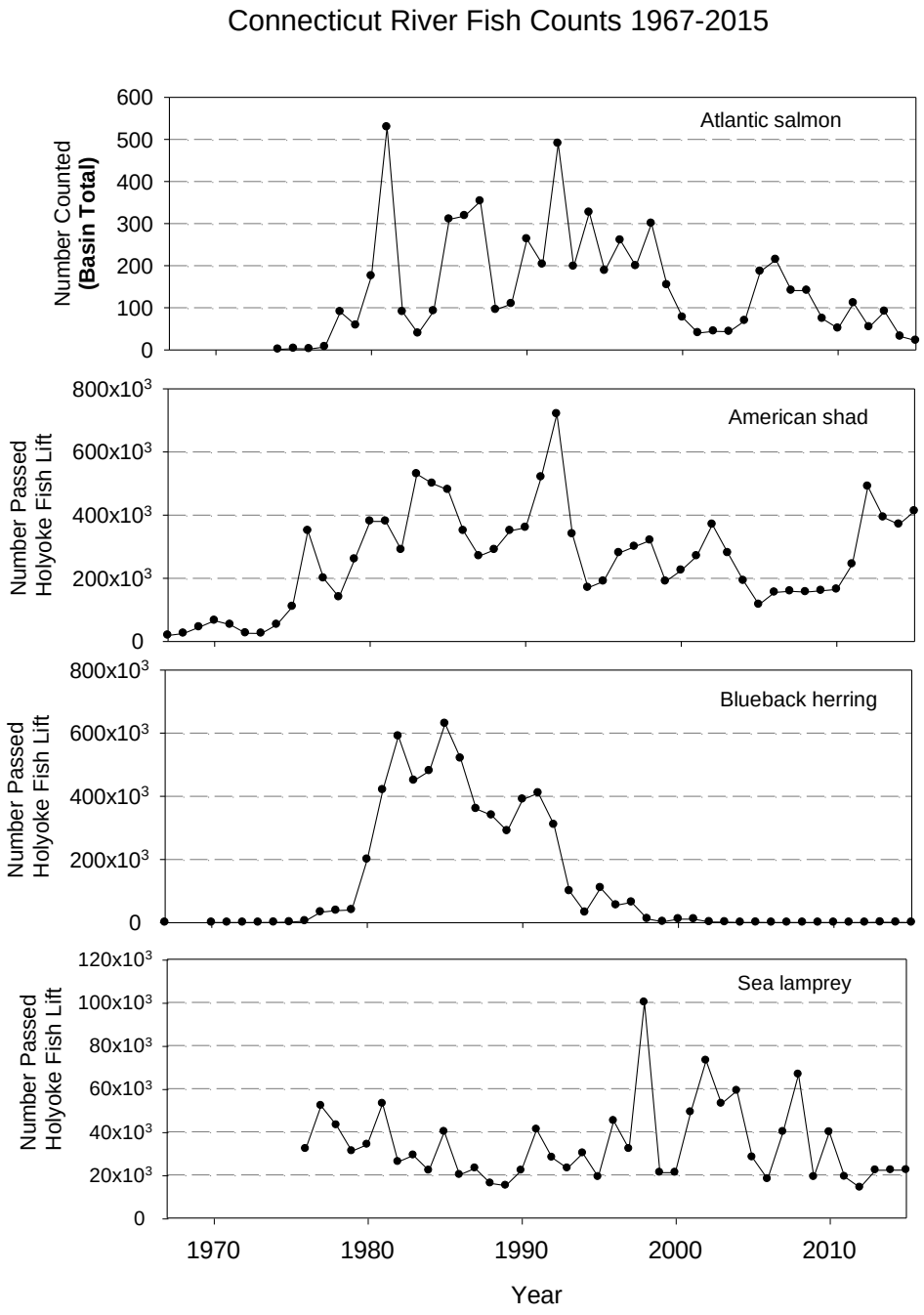

Figure 7. Select count summary of Atlantic salmon returns to Connecticut River basin (all facilities), and Holyoke Fish Lift passage counts for American shad, blueback herring and sea lamprey (1967-2015). Fish counts are affected by structural and operational changes (dams and fishways), and environmental conditions (temperature and flow/spill).

Table 8. American shad fishway passage counts 1980 – 2015, for Holyoke Dam, Turners Falls Dam (Gatehouse), and Vernon Dam.

Year	HFL Passed	Gatehouse Passed	% Gate vs. HFL #	Vernon Passed	%Vern vs. Gate #
1980	380,000	298	0.1		
1981	380,000	200	0.1	97	48.5
1982	290,000	11	0.0	9	81.8
1983	530,000	12,705	2.4	2,597	20.4
1984	500,000	4,333	0.9	335	7.7
1985	480,000	3,855	0.8	833	21.6
1986	350,000	17,858	5.1	982	5.5
1987	270,000	18,959	7.0	3,459	18.2
1988	290,000	15,787	5.4	1,370	8.7
1989	350,000	9,511	2.7	2,953	31.0
1990	360,000	27,908	7.8	10,894	39.0
1991	520,000	54,656	10.5	37,197	68.1
1992	720,000	60,089	8.3	31,155	51.8
1993	340,000	10,221	3.0	3,652	35.7
1994	170,000	3,729	2.2	2,681	71.9
1995	190,000	18,369	9.7	15,771	85.9
1996	280,000	16,192	5.8	18,844	116.4
1997	300,000	9,216	3.1	7,384	80.1
1998	320,000	10,527	3.3	7,289	69.2
1999	190,000	6,751	3.6	5,097	75.5
2000	225,000	2,590	1.2	1,548	59.8
2001	270,000	1,540	0.6	1,744	113.2
2002	370,000	2,870	0.8	356	12.4
2003	280,000			268	
2004	192,000	2,192	1.1	653	29.8
2005	116,511	1,581	1.4	167	10.6
2006	155,000	1,810	1.2	133	7.3
2007	158,807	2,248	1.4	65	2.9
2008	156,492	4,000	2.6	271	6.8
2009	160,649	3,813	2.4	16	0.4
2010	164,439	16,422	10.0	290	1.8
2011	244,177	16,798	6.9	46	0.3
2012	490,431	26,727	5.4	10,386	38.9
2013	392,494	35,293	9.0	18,220	51.6
2014	370,506	39,914	10.8	27,706	69.4
2015	412,656	58,079	14.1	39,771	68.5
Mean			**4.3**		**41.5**
SD			3.8		33.6

Spring 2015 river flows and water temperatures influenced shad passage rates at Holyoke Dam with the relatively high river discharge and cold water temperatures throughout the month of April followed in May by relatively low/sustain discharge into early June, with some short duration, relatively minor increases in discharge (Figure 8).

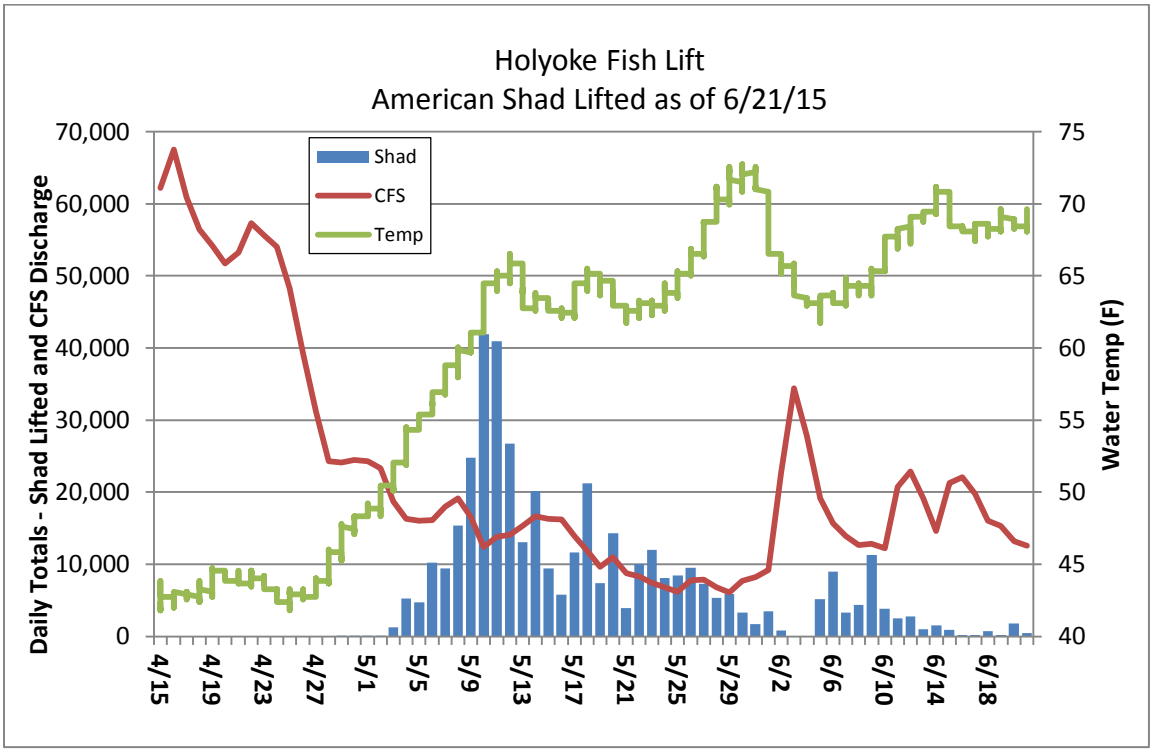

Figure 8. Holyoke Fish Lift daily American shad passage counts for the spring of 2015 (closure occurred on 6/21/15 for fish passage construction), with daily mean cubic feet per second (CFS) discharge value from USGS Holyoke Gage and sub-hourly water temperatures on second axis (°F).

Blueback Herring - A total of 87 blueback herring were counted at the Holyoke Fish Lift in 2015. River herring counts are not believed to reliably serve as a population metric for the lower river, and larger lower tributaries (downstream of fishways), where substantial spawning habitat occurs (refer to earlier report sections).

Sea Lamprey - A total of 24,597 sea lamprey were observed from fishways or estimated (CTDEEP nest counts) returning to the Connecticut River basin in 2015, which is slight decline from 2014. A total of 1,591 sea lamprey passed upstream of Rainbow Dam, Farmington River (decrease from 4,276 in 2014); 216 lamprey upstream of the West Springfield fishway, Westfield River (decrease from 1,127 in 2014); and 22,245 lampreys were passed upstream of the Holyoke Dam (22,136 in 2014). A total of 8,423 sea lamprey passed upstream of Turners Falls Dam (Gatehouse fishway count) an increase from 5,553 in 2014. A total of 2,519 passed upstream of Vernon Dam compared to 399 (2014), and 971 passed upstream of Bellows Falls Dam compared to 212 (2014). Sea lamprey counts at Holyoke Fish Lift have averaged 34,426 (± 18,053 SD) per year (period 1976-2014), and places the 2015 close to the 25th percentile for the time series.

Striped Bass - A total of 21 striped bass were counted at the Holyoke Fish Lift in 2015, a decrease from the 69 counted in 2014.

Gizzard Shad - A total of 84 gizzard shad were counted at the Holyoke Fish Lift in 2015, a decrease from 410 counted in 2014.

American eel – The American eel passage count using eel specific passes operated at Holyoke Dam, was 20,038 in 2015 for the period of May 14, through October 30, 2015. This is a

substantial decrease from the record passage/count total of 49,817 in 2014, but is the 5th highest in the seven year time series starting in 2009. Figure 9 shows eel passage count data from Holyoke Dam eel trap and collection equipment for 2015 in relation to mean daily river discharge. The Rainbow Dam eel pass (Farmington River) passed 689 in 2015 as compared to previous years totals: 1,905 eels in 2014; 910 eels in 2013; 197 eels in 2012; and 5,512 in 2011. The USFWS was petitioned to consider listing American eel under the Endangered Species Act in 2011 and on October 8, 2015 a decision of "*not warranted*" for listing was made and published in the Federal Register.

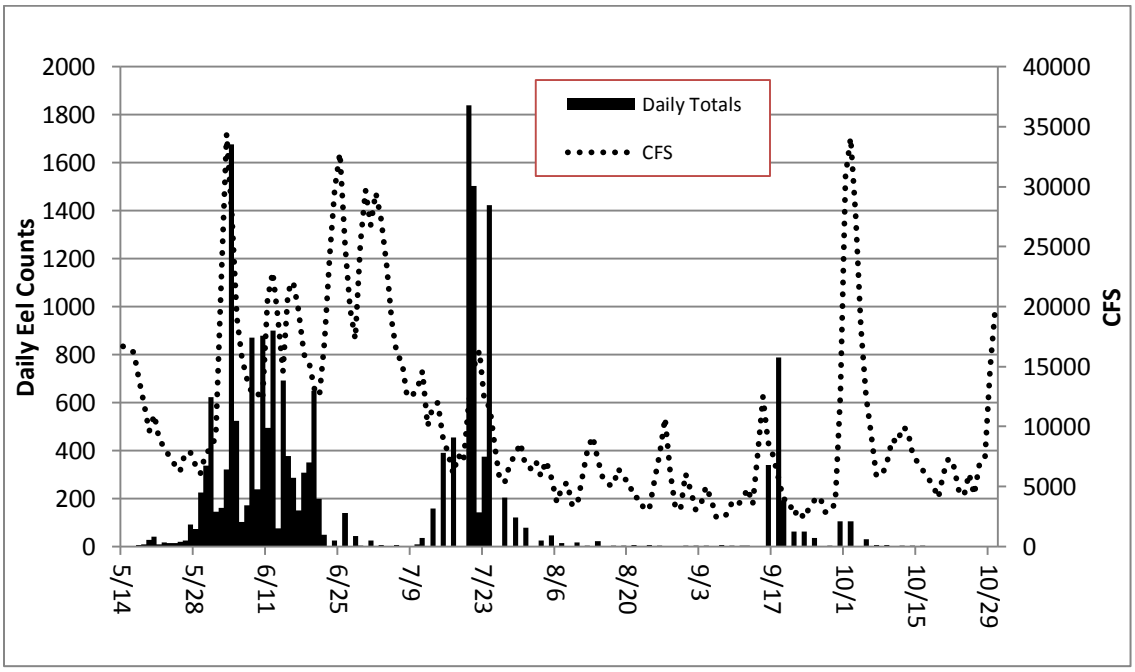

Figure 9. American eel daily counts from eel passes/traps at Holyoke Dam as provided end of October 2015, plotted with daily mean river discharge for USGS Holyoke gage.

- Smaller tributary fishways are operated and monitored in the basin, with most in the State of Connecticut (Table 9). CTDEEP actively monitors these fishways for important count data reported here. In the spring, weekly email reports from Steve Gephard (CTDEEP) are provided for these and other fishways fish counts.

Table 9. Fishway counts for smaller tributaries for select species. Previous year (2014) total count is shown in ( ).

Tributary	Fishway	Shad	Alewife	Blueback	Gizzard shad	Sea lamprey
Mill Brook, *Old Lyme, CT*	Mary Steube	-	134 (1543)	-	-	-
Eightmile River, *Lyme, CT*	Moulson Pond	19 (3)	72 (13)	11,690 (18)		34 (342*)
Mattabesset River, *Berlin, CT*	StanChem	15 (5)	31 (254)	18 (80)	10 (100)	46 (17)
Manhan River, *Easthampton, MA*	Manhan Dam					20* (54)

*Considered a partial count

Atlantic Salmon - A total of 22 sea-run Atlantic salmon adults were documented as returned to the Connecticut River watershed during 2015. This is a decrease from the 32 known returning adults in 2014 (Figure 7). Starting in the lower basin, one adult was observed in the Eightmile River (CT) – Moulson Pond Fishway, five in the Farmington River (CT) – Rainbow Dam Fishway, three in the Westfield River (MA) – West Springfield Dam Fishway, and 13 at the Holyoke Dam (MA). Adult salmon were released following a planned effort to trap, streamer tag, examine the fish, and obtain scale samples with the addition of a portion of the Holyoke Fish Lift salmon being captured and retained for CAFRC experiments on swimming performance (period of less < 48hr) before release in the main stem adjacent to the laboratory. A total of 8 fish from Holyoke were utilized in this study before their release. Some fish were not handled to avoid injury or stress at time of capture or were only observed by video monitoring. Nearly all adults were counted in the spring with two fish passed in the fall at Rainbow Dam.

Movement information of adult salmon upstream of Holyoke Dam is limited as no radio tagging occurred. The Westfield River trapped fish were transported and released upstream of dams with no upstream passage into suitable habitat, the only facility to undertake this action. From the 13 adults counted at Holyoke (including the 8 transported/held/released by CAFRC)), three were observed passing Turners Falls Dam, six were observed passing at Vernon Dam, and none passed upstream of Bellow Falls Dam. In the late fall 2015, CTDEEP identified several sea-run salmon redds in the main stem Farmington River.

All examined sea-run adults were wild (fry stock) origin. Scale reading was possible for 19 of the adults that were physically sampled. Four of the 22 fish were one-sea winter (grilse) as determined by scales (or size if not captured). Eighteen of the 22 fish were multi-sea winter fish. From the 19 scale aged fish, freshwater age could not be determined for four fish; of the balance three were age-1 smolts, and 12 were age-2 smolts.

Juvenile Atlantic Salmon Releases
A total of 390,667 salmon fry were stocked, solely in the State of Connecticut in 2015. The Farmington River received 268,961 fry and the Salmon River received 121,706 fry. This compares to a total of 198,957 fry stocked in 2014 in that state. The final multi-state stock out of 1.95 million fry occurred in 2013, which was also a substantial reduction from preceding years.

Fish Passage
There has been a diversity of activities related to fish passage, some of which are highlighted in this section. John Warner continues as our USFWS lead Hydropower Coordinator. In this report period, the CRASC decided to only require the operation of late fall adult salmon downstream measures in cases were 50 or more adults salmon were documented as passing upstream of a facility and also not have FirstLight Power install their smolt barrier net at Northfield Mountain Pump Storage facility to eliminate potential interference with several FERC relicensing studies. In addition, TransCanada operated their Vernon, Bellows Falls, and Wilder upstream fishways from the earliest possible start date continuously through the late fall 2015 as a relicensing study. Fishway inspections prior to the start or early in operations occurred under the direction of USFWS Engineers Brett Towler and Brian Waz (Vernon, Turners Falls, Holyoke, and on Westfield River -West Springfield Dam).

Holyoke Dam – the new downstream fish passage plans, with assistance of USFWS Engineer Brett Towler were finalized and construction was initiated in June 2015. The Holyoke Fish Lift was closed early with agency approval to facilitate this important work on June 21, 2015. Draft

Study Plans to evaluate downstream passage for American eel (adults) and American shad (adults) were developed by Holyoke Gas and Electric's consultants that were reviewed and comments were provided in 2015. Shortnose sturgeon evaluation plans were not yet developed at the time of this report but are required. As of the fall 2015, all required construction at Holyoke Dam was successfully completed as designed, with regular site review visits by agency staff.

Turners Falls Dam and Northfield Mountain Pump Storage – Numerous FERC relicensing studies were implemented in 2015 (spring, summer and fall) to examine a potentially wide range of project operations/effects to fish/aquatic species, their various life stages and life history events, aquatic habitats, and fish passage (up and downstream) as examples. The list of studies and their status is too large to list here but can be reviewed on-line at the Coordinator's web site (http://www.fws.gov/r5crc) or by contacting the Coordinator. Meetings, correspondences, planning, review of preliminary information, study modifications, all occurred over the report period. Studies involving radio tagging of adult shad, sea lamprey, American eel, and juvenile shad were all coordinated and cooperatively conducted (i.e., shared data, tag frequencies) with TransCanada for studies with identical objectives.

Vernon, Bellows Falls, and Wilder Dam – Numerous Relicensing studies were implemented in 2015 (spring, summer and fall) to address a suite of species, life stages, habitats and operations, and fish life history events. The list of studies and their status is too large to list here but can be reviewed on-line at the Coordinator's web site (http://www.fws.gov/r5crc). Meetings, correspondences, planning, review of preliminary information, modifications, all occurred over the report period. Studies involving radio tagging of adult shad, sea lamprey, American eel, and juvenile shad were all coordinated and cooperatively conducted with FirstLight Power.

On December 30, 2014, the Vermont Yankee Nuclear Power Station (Vernon, VT) ceased operations permanently, per owner Entergy's plan, with paperwork for the shut-down of the plant submitted to the Nuclear Regulatory Commission. The plant had been in operation since November 1972. This planned 2014 shut-down (declared in August 2013 by Entergy) had resulted in the deferment of numerous FERC hydropower relicensing studies until 2015, given future river conditions will be absent that plant's previous permitted release of (heated) cooling water that had been under increased critical review by the agencies regarding fish passage at Vernon Dam.

Appendix A. History of the Anadromous Fish Program

Native diadromous fishes (diadromy includes anadromous and catadromous fishes, with eel being the only catadromous species in this basin) were once abundant in the Connecticut River basin excluded from habitat only by natural barriers and their physiological limitations. Atlantic salmon ascended the main stem Connecticut River to Beechers Falls, VT, nearly 400 miles upriver from its outlet at Long Island Sound. American eel have been documented even farther upstream in the basin by early New Hampshire Fish Game studies. No fishery management or scientific information exists that provides a technical description of the pre-colonial diadromous fish populations. However, historical accounts of the region are filled with references to large American shad, river herring and Atlantic salmon runs which were known to have been an important food source in the spring for the native people and early European settlers. As colonization by Europeans and the development of water power sites expanded throughout the basin, anadromous fish populations notably declined. A major cause of the declines or loss of runs was largely the construction of dams that blocked fish migrations from reaching their spawning habitat (Figure 1). The first dam across the main stem Connecticut River was constructed as early as 1798, near the present site of Turners Falls, MA. It blocked returning American shad, river herring, Atlantic salmon and sea lamprey from access to the remaining spawning habitat in the northern portion of the river basin. As a result, those species and their abundance simply disappeared from both New Hampshire and Vermont. Tributaries were more easily dammed and so elimination of these species progressed rapidly in these areas first, with settlement and use of early water power for mills.

An interagency state/federal program to restore salmon to the Connecticut River based on the stocking of fry hatched from eggs taken from Penobscot River salmon was initiated in the 1860s, decades after the construction of the Holyoke Dam, MA. Although the effort resulted in the return of hundreds of adult salmon for several years in the 1870s and 1880s, the program eventually failed due to both uncontrolled harvest of fish in Connecticut waters and the failure to construct effective fish passage at dams in Massachusetts. Concurrent with the salmon restoration effort were the state's American shad culture and stocking efforts to enhance reduced runs, operated by the fish culture pioneer Seth Green.

Although interest continued in restoring salmon in the basin, no action was taken for many decades due to the lack of funds and the lack of effective fish passage technology (an early design fish ladder had been installed at Holyoke Dam). The condition of the river environment continued to deteriorate in response to widespread pollution and dam construction through the early to mid-1900s. By the 1960s, some tributary dams were breached and pollution abatement programs were initiated. Long term cooperative restoration programs became feasible with the passage of the federal Anadromous Fish Conservation Act of 1965 (P.L. 89-304) which made funds available for interstate fish restoration programs. The combined effects of all these events set the stage for anadromous species restoration. In 1967 the four basin states, USFWS, and NMFS signed a statement of intent to restore anadromous fishes including American shad, Atlantic salmon, and river herring to the Connecticut River. Atlantic salmon were a focus due to its appeal for recreational angling opportunities by the resource agencies. Early salmon stockings were initially comprised of two-year old smolts of Canadian origin reared in federal trout hatcheries that had recently been converted to salmon production. The first adult salmon return from these smolt releases was documented in 1974.

Early in the Salmon Program, the management emphasis was placed on stocking smolts with the USFWS building a salmon hatchery in Bethel, VT, and CTDEEP and MADFW converting trout hatcheries for salmon production. Production of stream-reared smolts, from juvenile stockings, was combined with smolts produced in hatcheries to increase smolt emigration from the river. A major effort was begun in 1987 to stock fry into appropriate habitat in the basin, based upon research.

Beginning in 1994, the Program utilized only "Connecticut River" fish, with no introductions of genetic material from outside the basin. Genetic monitoring had demonstrated the development of some unique genetic characteristics (alleles) that distinguish the Connecticut River population from other populations at that scale. The use of conservation genetics enabled the Program to maintain a genetically healthy population to maximize genetic diversity and reduce risks from genetic issues.

Adult salmon returns per 10,000 stocked fry declined dramatically from what had been documented from 1979 through 1994, when this rate averaged 0.71 (high of 1.6). For the period 1995 through 2008, the mean adult/10,000 fry stocked was 0.11 (refer to U.S. Atlantic Salmon Assessment Committee Report 27 – 2014 Activities (http://www.nefsc.noaa.gov/USASAC/Reports/). This latter period is when the program shifted to fry stocking as the primary restoration strategy, coinciding with this unexpected decline in fry return rates (due to marine survival rates decreases). This translated to a sustained reduction on the order of 1/6 of what had been observed for this rate (< 1994) even as issues of safe downstream passage of smolts at hydropower facilities and ocean fishery closures were completed. Studies over time have shown shifts in salmon marine prey species abundance and distributions, shifts in predator assemblages, and shifts in marine habitat area use as explained by climate change, are likely contributing factors.

The severe damage to the White River National Fish Hatchery (WRNFH) in fall of 2011, from a flood event, severely impacted the Salmon Program as it maintained a high proportion of the domestic broodstock and subsequently annual egg and fry production for all the states. WRNFH had been producing approximately 65% of the fry for the Program in the preceding 10 years. The loss of this facility, in conjunction with ongoing reviews of the best science and information related to restoration efforts, and emerging USFWS Northeast Region fisheries issues and priorities, led the USFWS to announce its decision to conclude fish culture activities for the Connecticut River Atlantic Salmon Program. That announcement was made in public at the July 2012 Connecticut River Atlantic Salmon Commission meeting. Subsequently, in the fall of 2012, the Commonwealth of Massachusetts decided it would no longer culture salmon at its Roger Reed State Hatchery. The last spawning of domestic salmon broodstock occurred at that facility in 2012, with all fry and remaining Connecticut River salmon of various ages stocked out in 2013. The State of New Hampshire had concluded the restoration effort with a last stocking in 2012 while the final stocking in Vermont was in 2013.

The State of Connecticut currently operates a "Salmon Legacy Program," which is not a restoration program but serves other defined goals and objectives. The goal of that program is to maintain Atlantic salmon in select watersheds, maintain existing genetics of the Connecticut River salmon, provide fish for their state broodstock fishery program (outside of the Connecticut River basin), and support educational programs such as the school egg/fry rearing program.

Action to provide upstream fish passage on the Connecticut river had begun prior to the Anadromous Fish Act, when in 1955, a rudimentary fish lift was constructed at Holyoke Dam to pass American shad and river herring, that relied on humans pushing them in wheeled buckets. At that time, and for approximately three decades after, the Enfield Dam remained a barrier, even though laddered, under many flow conditions for migrating fishes, eventually disintegrating completely in the 1980s. The Holyoke Dam facility was expanded in 1976 when substantial upstream passage modifications occurred, although not studied, upstream passage efficiency appeared to improve greatly with corresponding increases in annual counts (Figure 7). Other fishways built at dams on the main stem river and tributaries allowed returning salmon, shad, river herring, and sea lamprey access into select portions of the basin (with varying degrees of fishway effectiveness) targeted for restoration. Major issues with several different fishways have been apparent relative to ineffectiveness at passing shad and herring. These issues have been dealt with on a case by case basis, with varied degrees, or not, of success. However, with the Federal Energy Regulatory Commission's five main stem project relicensing underway (through 2018), opportunities for improvements for fish passage are anticipated along with plans to address other problem sites in the near future (e.g., Rainbow Fishway on the Farmington River).

Upstream passage at Turners Falls Dam fishways (first operational in 1980) have been studied and modified for decades and is one of the projects in the FERC relicensing process at this time. Passage issues relative to American shad are best explained by the fact that no ladders of the size required on the main stem had been designed for that species at that point in time. USFWS relied on best information (no specific studies available) at the time that suggested West Coast fish ladders on the Columbia River were effective at passing American shad. This led to the adoption of these designs, downsized considerably from the Columbia River, for use on the main stem dams. The USFWS worked with the power companies in the design and construction, using the best information available to develop operating parameters for flow, velocities, and turbulence measures.

Vernon Dam (VT) fish ladder became operational in 1981 with Bellows Falls and Wilder dam fish ladders in following years. Adult returns, in most cases, were captured at the first fishway encountered in traps and then retained in hatcheries for fall spawning. As the number of salmon fry stocked in the basin increased during the late 1980s, concern grew for the deleterious effect of hydroelectric turbines on outmigrating smolts as well as juvenile and spent adult American shad. Efforts to provide safe and effective downstream fish passage on both main stem and tributary projects were initiated in the 1980s. In 1990, memoranda of agreement (MOA) were signed with two major utility companies that operated hydroelectric facilities at six main stem projects that established time frames for downstream passage construction. Efforts to provide necessary fish (all diadromous species) passage conditions at these projects and throughout the basin are ongoing. A recent example is Holyoke Dam and its new downstream passage facilities, designed specifically to address adult American eel and shortnose sturgeon that will be operational and evaluated with fish studies in 2016.

The state and federal agencies continue to work in close cooperation with our many partners to address pressing fishery management, protection, enhancement, and restoration matters for fish species, populations and habitats. This is important for the many ecological, recreational, and commercial benefits, both direct and indirectly derived from healthy fish populations and aquatic habitats. Ongoing work includes continuing efforts on many fronts to increase both abundance levels and distributions (particularly upper basin and in tributaries) as well as stock structure

characteristics to support population resilience (e.g., diverse age structures and repeat spawners). The current FERC relicensing process for the five main stem facilities is of paramount importance in this regard relative to the 30 or more year length of these federal licenses. The CRASC and its predecessor, the Connecticut River Policy Committee, have provided and continue to provide, a critical coordinated fishery leadership role from policy setting to project implementation, resulting in many positive outcomes not observed in other large East Coast river basins.